WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

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To avoid processing delays, also please be sure to include:

1. **Returnee's name, address, and phone number.**
2. **Model and Serial numbers.**
3. **Repair instructions.**

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

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MINIATURE MICROPROCESSOR
TEMPERATURE CONTROLLERS

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® CN9000 Series Miniature Microprocessor Controllers are designed for accurate, precise temperature control. They feature high accuracy and reliability, and the sophisticated PID with approach control (PDPI) for optimal control during start-up and steady-state operation.

The CN9000 Series feature models with user selectable input type from eight thermocouple types or 2-wire RTD, or models with 3-wire RTD input. These units are °C/°F switchable, offer a 0.1° resolution up to 200°, and the second set point and output are standard.

The CN9000 controllers are well suited to a broad range of applications, and are easy to install and operate. For most applications, the user need only select the desired input type by using the front pushbuttons. The CN9000 is pre-set for control parameters which are suitable for many applications. These pre-set (default) parameters can be changed by the operator at any time, to fine tune the controller to an individual process.

The CN9000 features advanced PDPI control, which enables the unit to suppress overshoot, and allows the process warm-up to be tuned independently from the steady-state operating conditions. For other processes, a user may select PID (Proportional-Integral-Derivative), PD (Proportional-Derivative), Proportional, or ON/OFF control.

Selection of all operational controls is made through the three keys on the front panel of the CN9000, with the display prompting the user for each step. After the parameters have been set, they can be locked-in by removing the jumper located under the front bezel. The user may select control mode and parameters, display resolution (1° or 0.1°) and units (°C/°F). An operator may also utilize a ranging feature of the instrument, which limits the range in which a set point may be chosen, or lock out a user from changing the set point.

The second set point and output of the CN9000 may have proportional or on/off control, and the set point is set as a deviation from the primary set point. Cycle time, proportional band and on/off deadband are all set independently of the primary set point.

The CN9000 display has a large 3½ digit green LED readout, with auxiliary indicators for output 1 and output 2, and three LEDs to indicate deviation from set point. The microprocessor, in addition to automatic processing of key calculations, holds the data in non-volatile memory — with the ability to retain data for up to 10 years with no power.

1.2 AVAILABLE MODELS

Refer to Figures 1-1 and 1-2, and Tables 1-1 and 1-2.

TABLE 1-1
HOW TO ORDER

MODEL	INPUT	OUTPUT 1	OUTPUT 2
CN9111	Thermocouple, 2-Wire RTD	Relay	Relay
CN9112		Relay	Pulse
CN9121		Pulse	Relay
CN9122		Pulse	Pulse
CN9131		1 A Triac	Relay
CN9141		4-20 mA	Relay
CN9151		0-10 Vdc	Relay
CN9211	3-Wire RTD	Relay	Relay
CN9212		Relay	Pulse
CN9221		Pulse	Relay
CN9222		Pulse	Pulse
CN9231		1 A Triac	Relay
CN9241		4-20 mA	Relay
CN9251		0-10 Vdc	Relay

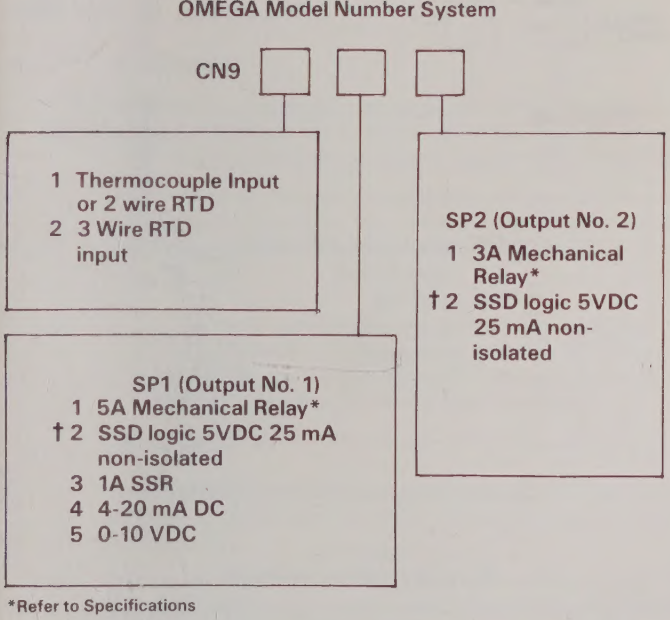


Figure 1-1. CN9000 Model Number System

† SSD = DC Solid State Driver

SSD output is a DC Solid State Driver (Pulse) designed to be used with DC Controlled Solid State Relay such as SSR240D45.

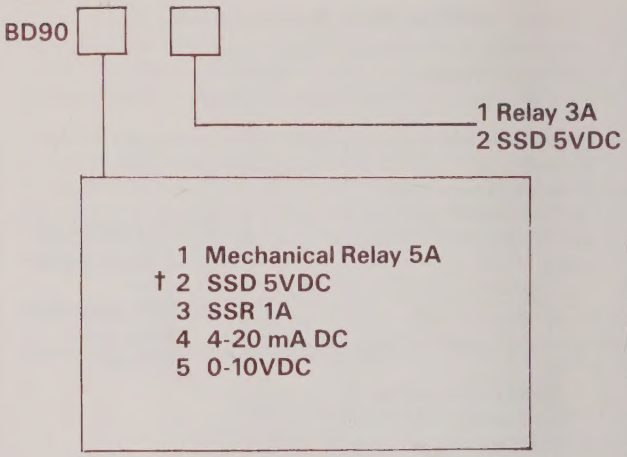


Figure 1-2. Replacement Relay Boards

TABLE 1-2
PLUG-IN OUTPUT BOARDS

MODEL	OUTPUT 1	OUTPUT 2
BD9011	Relay	Relay
BD9021	Pulse	Relay
BD9012	Relay	Pulse
BD9022	Pulse	Pulse
BD9031*	1 Amp Triac	Relay
BD9041*	4-20mA DC	Relay
BD9051*	0-10 Vdc	Relay

Requires that DB9021 is already installed in unit.

† SSD = DC Solid State Driver

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department at (203) 359-1660.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material in the event reshipment is necessary.

2.2 MOUNTING

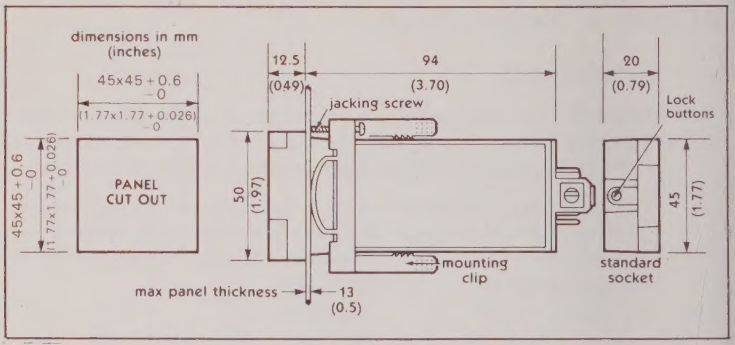
The CN9000 is mounted in the panel through a 45 mm square 1/16 DIN 43700 cutout using the special mounting clip provided (refer to Figure 2-1).

The mounting clip should be pressed home until the rachet holds the unit firmly in place. If necessary, the mounting can be further tightened using the jacking screws.

To remove the unit from the panel, press the legs of the clips in opposite directions to release the rachet.

NOTE

When mounting multiple units allow 3½ inches from center to center of the unit in the vertical direction to allow for mounting bracket and wiring, and 2 inches in the horizonal direction for heat dissipation.



*To unplug socket, press in lock buttons and pull apart

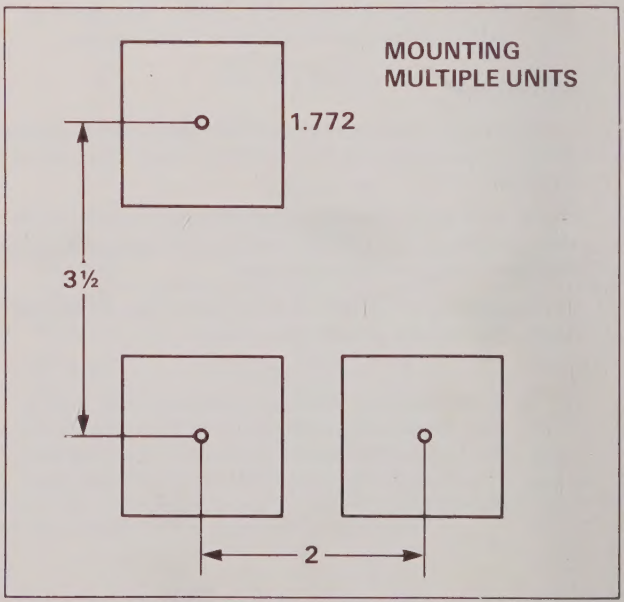


Figure 2-1. Mounting and Cutout Dimensions

2.3 WIRING

The CN9000 operates on either 115 Vac ±15%, 50-60 Hz (std) or 230 Vac ±15%, 50-60 Hz (selectable by changing internal jumper — refer to Addendum A). See Figure 2-2. The CN9000 Series feature (for SP1 or SP2) either the standard mechanical relay outputs or the optional non-isolated 5 Vdc pulse output (designed for operating an external DC SSR such as an OMEGA SSR240D10, SSR240D25, or SSR240D45). Three other optional outputs are available for SP1, using a plug-in output power socket (provided). These outputs are, a 1A SSR, 0 to 10 V, or 4 to 20 mA output.

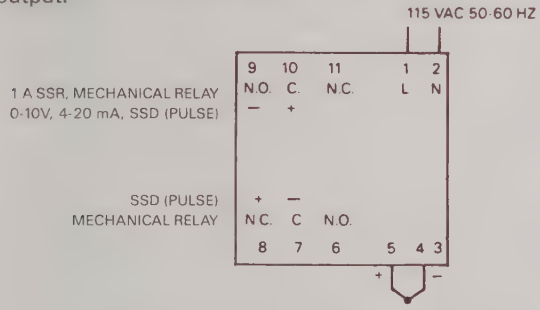


Figure 2-2. Wiring Connections

TERMINAL DESIGNATIONS

1 Controller Power 115 Vac (230 Vac optional)
2 Controller Power Neutral

---

3 RTD (third wire)
4 Thermocouple (−) or RTD
5 Thermocouple (+) or RTD

---

6 SP2 Mechanical Relay Normally Open (N.O.)
7 SP2 Mechanical Relay Common (C.); or 5V Pulse (−)
8 SP2 Mechanical Relay Normally Closed (N.C.); or 5V Pulse (+)

---

9 SP1 Mechanical Relay N.O.; 1 A SSR N.O.; 5V Pulse (−); 0-10V (−); or 4-20 mA (−)
10 SP1 Mechanical Relay C.; 1 A SSR C; 5V Pulse (+); 0-10V (+); or 4-20 mA (+)
11 SP1 Mechanical Relay N.C.; or 1 A SSR N.C.

CAUTION

Check side label for supply voltage.

Thermocouple types J, K, T, E, R, S, N, J DIN, and PT100 RTD (2-wire) are selectable via the keys on the CN9000 front panel (refer to Figure 2-3 for input wiring configurations). 3-wire configuration is available by internal jumper change (refer to Addendum A).

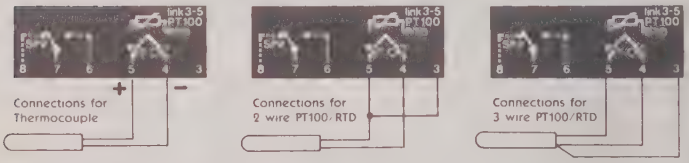


Figure 2-3. Thermocouple and RTD Input Wiring

2.4 TYPICAL WIRING DIAGRAMS

Figures 2-4 and 2-5 illustrate typical wiring of the CN9000 Controllers.

(Standard controllers operate on 115VAC, 60 Hz, --- 230 VAC operation is optional)

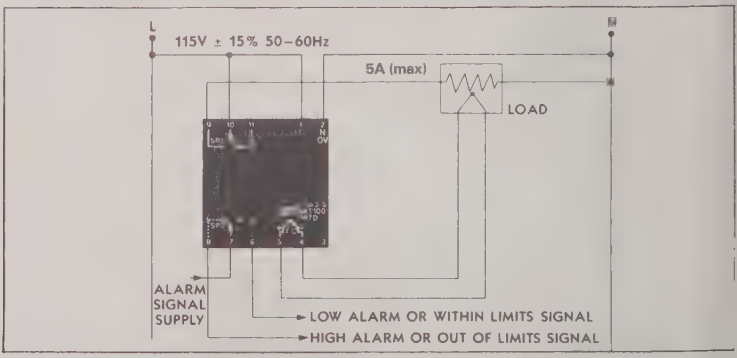


Figure 2-4. Wiring Heater with Alarms (Two Mechanical Relays-Model CN9111)

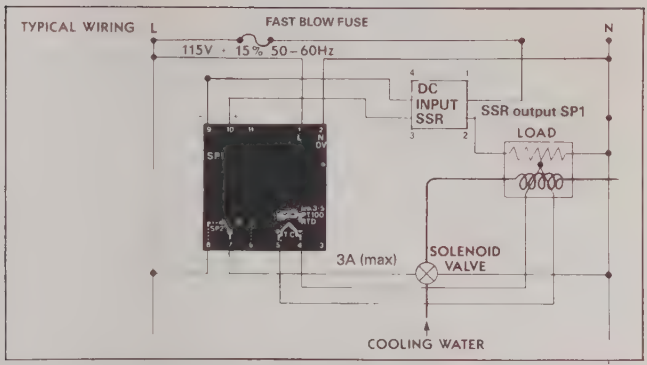


Figure 2-5. Heating and Cooling CN9121 [One DC Solid State Relay Driver for Heating (SP1), 3A Mechanical Relay for Cooling (SP2)]

NOTE

The CN9000 Series has been designed to be as immune as possible to electrical interference. However, electrical noise suppression may be required in some applications, particularly if the output of the controller is firing a contactor or coil. A noise suppression kit is available for use with 115 Vac, OMEGA part no. 1821-101 (consists of an RC network or metal oxide varistor (MOV).

SECTION 3 OPERATION

3.1 GENERAL CONSIDERATIONS

The CN9000 is pre-set for control parameters that are suitable for many applications. The CN9000 can be operated with the default (pre-set) settings, or the default settings can be overridden by more appropriate control modes and parameters and/or enabling of the second set point, by programming the CN9000 through the front panel keys. Refer to Table 3-1 Controls and Indicators and Table 3-4 Functions and Options.

3.2 CONTROLS AND INDICATORS

Figure 3-1 and Table 3-1 illustrate the controls and indicators of the CN9000 Series Controllers.

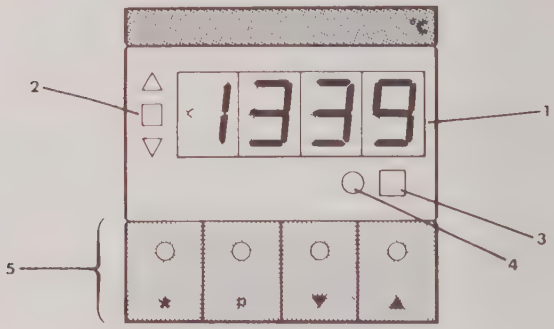


Figure 3-1. Controls and Indicators

TABLE 3-1
CONTROLS AND INDICATORS

ITEM	CONTROL/INDICATOR	FUNCTION
1.	LED Display	The four-digit display normally shows process temperature to 1°C or F and in high resolution (up to 200°) 0.1°C or F. The display also shows the set point value (flashing) and the FUNCTION and OPTION list when in the Set-Up Mode (for changing default parameters). Functions are the available controller facilities (e.g., Derivative); Options are the available values for each Function (e.g., Derivative value — 50 seconds). When in the Set-Up Mode, the Function numbers are on the right and the Option numbers are on the left of the floating decimal point.

TABLE 3-1 (cont'd)
CONTROLS AND INDICATORS

ITEM	CONTROL/INDICATOR	FUNCTION
2	Error Indicator	These three LEDs display the difference between set point and process temperatures in five steps, each one representing 2% of full scale value. Flashing > 3% above set point Steady 1%-3% above set point Steady ±1% about set point Steady 1%-3% below set point Flashing > 3% below set point The error indicator can also be used in high resolution, ±1% steps or low resolution, ±4% steps.
3	SP1 Output Indicator	This LED is illuminated (green) when SP1 output ON.
4	SP2 Output Indicator	Illuminated SP2 output ON or OFF depending on mode of operation (amber). Refer to Table 3-6, Set Point 2 Operation.
5	Control Keys	★ When pressed displays main set point (SP1) temperature. ★ ▲ Keyed together increases main set point temperature. ★ ▼ Keyed together decreases main set point temperature. p Selects Set-Up Mode (entry to Function and Option List — see Table 3-2). Display flashes, normal control maintained. ▲ ▼ When in Set-Up Mode, indexes FUNCTION/ OPTION number up or down in single digits. ★ When in Set-Up Mode changes manipulation from Functions to Options and vice-versa.

3.3 DEFAULT (PRE-SET) SETTINGS

For ease of use in normal applications, the CN9000 has been pre-set with factory, or DEFAULT, settings in place of customer options. (To change parameters refer to paragraph 3.5 and Table 3-4.)

These pre-set parameters enable the instrument to operate in PID Control Mode, with a single set point and slow cycle relay output. This configuration should give good results where the heater is adequately rated and the control sensor is sited reasonably close to it.

Default settings (for SP1 only) are:

Proportional Time (Cycle Rate) = 30 seconds

Proportional Band (Gain) = 2.5% of Default full scale

Derivative Time (Rate) = 25 seconds

Integral Time (Reset) = 350 seconds

To use the controller with default settings requires only that the Option number of the sensor, selected from Table 3-2, Sensor Default Set Point Range Table, be keyed into the instrument. Also, check that the instrument is set to either °C or °F, as desired. (Refer to paragraph 3.5 and Table 3-4.) Also check that the desired control temperature is within the set point Default range (see the following).

To operate unit:

Apply power. All LED segments will be briefly illuminated during the self-check routine, then the display will request sensor selection (from Table 3-2), i.e., the Option number for Function 16, and will not respond to any further instructions until this is made.

3.3.1 Changing the Allowable Set Point Range

The Default Range will limit the set point values only. The instrument will indicate process temperatures over the full linearized range shown in Table 3-5. The Default set point full scale (automatically selected by choice of sensor) may be altered to any value within the linearized band (Table 3-5) by using the following procedure:

1. Press P (use blunt-pointed tool-P is a recessed button) once and release.
2. Press P again and hold.
3. Press ★ and hold.
4. Release P (hold ★). Default full scale flashes on display.
5. Press either ▲ or ▼ to adjust full scale value.
6. Release ▲ or ▼.
7. Release ★.
8. Repeat steps 1-4 to view new full scale value.
9. Adjust set point to desired value.

CAUTION

Ensure that the set point range maximum is compatible with safety requirements.

NOTE

If an attempt is made to set the set point outside of the set point range, the set point will be at the end of the range.

TABLE 3-2
SENSOR DEFAULT SET POINT RANGE TABLE

Option	Type		Min/Max °C	°F
1.	J	Iron-Constantan	0-400	32-800
2.	K	Chromel-Alumel	0-400	32-800
3.	N	Nicrosil-Nicrosil	0-400	32-800
4.	R	Pt/Pt-13% Rh	0-1600	32-1999
5.	S	Pt/Pt-10% Rh	0-1600	32-1999
6.	T	Copper-Constantan	0-250	32-500
7.	E	Chromel-Constantan	0-500	32-1000
8.	J DIN		0-400	32-800
9.	Pt 100 RTD		0-200	32 400

Note: If the Default set point range maximum is not suitable, it can be increased or decreased to any desired value within the linearized band.

3.4 OPERATION WITH DEFAULT SETTINGS

Refer to Table 3 3 for operation of the CN9000 with the Default settings.

TABLE 3-3
OPERATION WITH DEFAULT SETTINGS

STEP	ACTION	DISPLAY
1 Install Unit. Power on. Check that display reads:	* Note: digits shown bold are flashing	0 1 6
2 To key in the selected sensor type. Example: OPTION 2, K-Type thermocouple: Check that display reads:	PRESS ▲ TWICE	2 1 6
3 To enter the selected thermocouple type into memory: The display now reads sensor Temperature°, eg. Ambient (18°C).	PRESS P ONCE	1 8
4 To key in the set point value:	PRESS ★ and HOLD	0
To increase the set point:	PRESS ▲	
To decrease the set point:	PRESS ▼	
It should be noted that the digit rollover rate increases (ie. accelerate). eg. Set Point 250°C.		2 5 0
When the keys in (4) above are released the unit will operate as a normal temperature controller. The square LED, is illuminated, showing that SP1 output is energized. To view the set point temperature:	PRESS ★	
To adjust the set point value at any time:	REPEAT STEP 4	

Should a particular application require the use of additional features, for example: second setpoint output or High Resolution, refer to Paragraph 3.5. PARAMETER ADJUSTMENTS.

This also applies where the Default settings prove to be unsuitable. The CN9000 can be tuned for optimum performance by the adjustment of control parameters.

If guidance is needed to establish the appropriate settings, refer to Section 4: TUNING.

3.5 PARAMETER ADJUSTMENTS

To change the CN9000's Default parameters to new parameter settings refer to Tables 3-4 through 3-8. All adjustable parameters are held in memory.

NOTES

Because the selection of high resolution (Function 18 Option 1), °C/°F selection (Function 22), and set point range adjustments influence the values of other settings and can have a fundamental effect on control characteristics, it is important that, when required, they should be made during initial set-up to avoid the need for re-tuning.

If the temperature scale is changed, it is essential to change the upper bezel to correspond to the scale selected.

The following gives a description of the adjustable parameters listed in Table 3-4.

PARAMETER NUMBER	DESCRIPTION
1.	Manual Reset — If the CN9000 is used in Proportional only (P) or Proportional-Derivative without Automatic Reset (PD), the system is offset by altering, digitally, the amount of the offset in ±1° steps, up to half of the proportional band or ±99°, whichever is smaller.
2.	SP2 Adjust — Deviation from first set point in 1° steps, up to 99° (9.9° in high resolution). The second set point tracks the first set point. Therefore, if the first set point is changed, the second set point changes along with it.
3.	SP1 Lock — Allows the first set point to be locked to keep it from being changed inadvertently. This is the Function that the unit starts with when Parameter (P) key is first pressed.

PARAMETER NUMBER	DESCRIPTION
4.	SP1 Proportional Time (Cycle Time) — Total length of time that the output will cycle on and off when the temperature is within the proportional band. This can also be set for ON/OFF Control. Note that cycle times of less than 10 seconds are not recommended for use when SP1 is a mechanical relay. The 0.05 second time should only be used with analog outputs (4-20 mAdc or 0-10 Vdc) which will be available at a future time.
5.	SP1 Proportional Band — This is the percent of the Span (allowable set point range) (linearized range) both below and above set point in which proportion action is active. Output is 100% at the bottom of the proportional band, 0% at the top, and proportional in between. If ON/OFF Control was selected (Function 4, Option 7), then this selection represents deadband (hysteresis), or the amount the temperature must fall after reaching set point before the relay returns to original state.
6.	SP1 Derivative Time — Also known as rate. Refer to paragraph 4.5. Set to OUT (Option 1) if Proportional only Control is desired.
7.	SP1 Derivative Approach Control — Used to eliminate derivative action during system warm-up time. Refer to paragraph 4.6.
8.	SP1 Integral Time — Also known as reset. Refer to paragraph 4.4.
9.	Display Bias — Factory calibration. No adjustment required.
10.	SP2 Proportional Time — Cycle time for second set point. Set similar to first set point (Function 4). Note that SP2 must be activated in (Function 19). Pre-set default setting for SP2 is ON/OFF.
11.	SP2 Proportional Band — Set similar to first set point proportional band (Function 5).
12.	Error Indication Resolution — Allows adjustment in the indication of the deviation from set point.
13.	Not used.

PARAMETER NUMBER	DESCRIPTION
14.	Derivative Polling Ratio — Allows adjustment of the frequency at which the controller checks the derivative function. This should not have to be adjusted from the Default value (0.5 x Derivative Time) for most processes. Not applicable if SP1 derivative is not used.
15.	Reset All Functions To Default — Allows quick reset of all functions to Default settings. Only Function 22 (C/F) will not be reset.
16.	Sensor select — Selects thermocouple type or RTD. This is the first selection that must be made for unit to be used. Note: if 3-wire RTD configuration is ordered, then PT100 (Option 9) must be selected.
17.	Negative Temperature Ranges — Must be enabled to allow negative temperatures to be measured (using either T thermocouple or RTD only).
18.	High Resolution — Allows selection of 0.1° resolution over limited temperature range (−99.9 to 199.9).
19.	SP2 Operating Mode — Allows for activation of second set point. See SP2 Operation Table, 3-6. Note that in ON/OFF mode SP2 acts as a deviation alarm from the first set point. It can be set as a high deviation, low deviation, or either high or low deviation (out of bounds).
20.	SP1 Sensor Burnout Protection — Allows for selection of upscale or downscale thermocouple break protection for first set point so that output will be in safest state if input is lost. Most heating applications require upscale protection.
21.	SP2 Sensor Burnout Protection — Allows for selection of upscale or downscale protection for second output.
22.	°C/°F — Allows selection of °C or °F for display. Note that correct bezel must be used.
23.	Not used.

TABLE 3-4
FUNCTIONS AND OPTIONS

FUNCTION NUMBER	OPTION NUMBER	PARAMETER

NOTE: For each Function, 0 is the Default Setting.

1		**Manual Reset**
	Adjusting offset. Key in correction (in degrees)	±1° steps Range: Prop Band ÷ 2 (max 99°)
2		**SP2 Adjust**
	Key in setting (from SP1) in degrees	1° steps Range: 0° to 99° (inoperative until Option selected at Function 19)
3		**SP1 Lock**
	0	Unlocked
	1	Locked
4		**SP1 Prop Time (Cycle Time)**
	0	30 sec
	1	1 sec (not recommended with mechanical relay)
	2	5 sec (not recommended with mechanical relay)
	3	10 sec
	4	20 sec
	5	60 sec
	6	0.05 sec (for use with the 0-10V or 4-20 mA output options)
	7	ON/OFF

5		**SP1 Prop Band**	**Hystersis (Dead Band)**
	0	2.5%	1.25%
	1	0.5%	0.25%
	2	1%	0.5%
% of span	3	2%	1.0%
	4	3%	1.5%

TABLE 3-4 (cont'd)
FUNCTIONS AND OPTIONS

FUNCTION NUMBER	OPTION NUMBER	PARAMETER	
5 (cont'd)		**SP1 Prop Band**	**Hystersis (Dead Band)**
	5	5%	2.5%
	6	10%	5.0%
	7	20%	10.0%
		PD, P mode: Max 255° (25.5° in Hi-Res); PID mode: Max. 127° (12.7° in Hi-Res)	
6		**SP1 Derivative Time**	
	0	25 sec	
	1	OUT	
	2	5 sec	
	3	10 sec	
	4	50 sec	
	5	100 sec	
	6	200 sec	
7		**SP1 Derivative Approach Control**	
	0	1.5(x) Prop Band	
	1	0.5	
	2	1.0	
	3	2.0	
	4	2.5	
	5	3.0	
	6	4.0	
	7	5.0	
8		**SP1 Integral Time**	
	0	350 sec	
	1	OUT	
	2	25 sec	
	3	50 sec	
	4	100 sec	
	5	200 sec	
	6	600 sec	
	7	1000 sec	

TABLE 3-4 (cont'd)
FUNCTIONS AND OPTIONS

FUNCTION NUMBER	OPTION NUMBER	PARAMETER
9		Display Bias (not required in normal operation, refer to paragraph 3.10 Calibration)
10		**SP2 Prop Time (Cycle Time)**
	0	ON/OFF
	1	1 sec (not recommended with mechanical relay)
	2	5 sec (not recommended with mechanical relay)
	3	10 sec
	4	20 sec
	5	60 sec
	6	0.05 sec (for use with the 0-10V or 4-20 mA output options)
	7	30 sec
11		**SP2 Prop Band** / **Hysterisis (Dead Band)**
	0	2.5% / 1.25%
	1	0.5% / 0.25%
	2	1% / 0.5%
	3	2% / 1.0%
% of span	4	3% / 1.5%
	5	5% / 2.5%
	6	10% / 5.0%
	7	20% / 10.0%
		PD, P mode:Max 255° (25.5° in Hi-Res); PID mode: Max 127° (12.7° in Hi-Res)
12		**Error Indication Resolution**
	0	Normal (2% x FS per segment)
	1	High (1% x FS per segment)
	2	Low (4% x FS per segment)
13		**Spare**

TABLE 3-4 (cont'd)
FUNCTIONS AND OPTIONS

FUNCTION NUMBER	OPTION NUMBER	PARAMETER
14		**Derivative Polling Ratio**
	0	0.5x Derivative Time
	1	0.2x Derivative Time
	2	0.7x Derivative Time
	3	1.0x Derivative Time
15		**Reset all Functions to Default**
	0	Normal
	1	Reset

NOTE: The selection of Option 1 at Function 15 will return all settings to Default except for the selection of °C or °F and Display Bias.

16		**Sensor Select**
	0	None. Controller inoperable.
	1	J
	2	K
	3	N
	4	R
	5	S
	6	T
	7	E
	8	J-DIN
	9	Pt100 RTD
17		**Negative Temperature Ranging**
	0	Disabled
	1	Enabled
18		**High Resolution**
	0	Normal
	1	Hi-res (−99.9 to 199.9) Settings in 1° increments become 0.1° increments in High Resolution.
19		**SP2 Operating Mode**
	0	OUT
	1	High (above SP1)
	2	Low (below SP1)
	3	Out of limits

TABLE 3-4 (cont'd)
FUNCTIONS AND OPTIONS

FUNCTION NUMBER	OPTION NUMBER	PARAMETER
20		**SP1 Sensor Burnout Protection**
	0	SP1 output OFF (UPSCALE)
	1	SP2 output ON (DOWNSCALE)
21		**SP2 Sensor Burnout Protection**
	0	SP2 output OFF (UPSCALE)
	1	SP2 output ON (DOWNSCALE)
22		**°C/°F**
	0	°C
	1	°F
23	1	**Version No. (factory set)**

TABLE 3-5
LINEARIZED SENSOR RANGE TABLE

OPTION NO.	SENSOR TYPE	DEFAULT RANGE °C MIN	DEFAULT RANGE °C MAX	DEFAULT RANGE °F MIN	DEFAULT RANGE °F MAX	LINEARIZED RANGE °C MIN	LINEARIZED RANGE °C MAX	LINEARIZED RANGE °F MIN	LINEARIZED RANGE °F MAX
1	J	0	400	32	800	0	800	32	1470
2	K	0	400	32	800	0	1200	32	1999
3	N	0	400	32	800	0	1200	32	1999
4	R	0	1600	32	1999	0	1600	32	1999
5	S	0	1600	32	1999	0	1600	32	1999
6	T	0	250	32	500	−90	250	−130	480
7	E	0	500	32	1000	0	600	32	1110
8	J DIN	0	400	32	800	0	800	32	1470
9	Pt100	0	200	32	400	−90	400	−130	750

NOTE: Range adjustments (including Default) only limit set point values. Process temperatures will be displayed over the full linearized range.

TABLE 3-6
SP2 OPERATION

Control Mode (Function 10)	Operating Mode (Function 19) Setting Compared to SP 1	SP2 Relay Is Energized	SP2 LED Is On	Typical Examples of Use
ON/OFF (Option 0)	High (Above SP1) Option 1	Below SP2 Setting	Above SP2 Setting	Deviation Alarm High
	Low (Below SP1) Option 2	Above SP2 Setting	Below SP2 Setting	Deviation Alarm Low
	Out of Limits (About SP1) Option 3	Within Set Band Around SP1 Setting	Outside Set Band Around SP1 Setting	Deviation Alarm High & Low
Proportional (Options 1-7)	High (Above SP1) Option 1	Above SP2 Setting	Above SP2 Setting	SP2 Cooling
	Low (Below SP1) Option 2	Below SP2 Setting	Below SP2 Setting	SP1 Cooling SP2 Heating

First Output Reverse Acting (Heating Only)

TABLE 3-7
MAKING PARAMETER ADJUSTMENTS

STEP	ACTION	DISPLAY
1 Ensure that the jumper behind the lower front bezel is in the Parameter Setting Position (see Parameter Lock, paragraph 3.8)		
2 To convert main display from temperature read-out into FUNCTION and OPTION listing mode. FUNCTION numbers appear to the right of, and OPTION numbers to the left of, the floating decimal point, starting with FUNCTION 3.	PRESS P	[ ][0][0][3]
The FUNCTION listing has been arranged to give easiest access to those which are almost frequently used.		
When indexing in a positive (▲) direction, FUNCTION 23 is followed by FUNCTION 3.		
FUNCTIONS 2 and 1 can be accessed from FUNCTION 3 by indexing in a negative (▼) direction. FUNCTION 1 is followed by FUNCTION 12.		

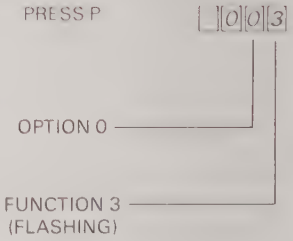


TABLE 3-7 (cont'd)
MAKING PARAMETER ADJUSTMENTS

STEP	ACTION	DISPLAY
3 To index sequentially. The FUNCTION digit(s) will flash indicating that the FUNCTIONS can be indexed sequentially from 3 to 23 enabling previously entered or Default OPTIONS to be viewed: e.g. FUNCTION 12 OPTION 2.	PRESS ▲ OR ▼	0212
4 To alter an OPTION: To cause the flashing of the display to shift from the FUNCTION column to the OPTION column to the left of the decimal point. Note that it is the flashing digit(s) that can be altered.	PRESS ★	212
To change OPTION number:	PRESS ▲▲▲	512
	OR PRESS ▼	412
To return to FUNCTION indexing: When all required OPTIONS have been selected for each FUNCTION, to place in memory and commence control under the new instructions:	PRESS ★	412
	PRESS P	TEMP

3.6 EXAMPLES OF PARAMETER ADJUSTMENTS

Refer to Table 3-8 for examples of parameter adjustments for the CN9000 Controller.

TABLE 3-8
EXAMPLES OF PARAMETER ADJUSTMENTS

STEP	ACTION	DISPLAY
A. CHANGING SP1 PROPORTIONING TIME		
To change SP1 proportioning time from 30 secs (Default setting) to 20 secs: FUNCTION 4: Change OPTION 0 to OPTION 4		
1 To display OPTION FUNCTION List: Ensure that link behind lower bezel is in 'unlocked' position.	PRESS P	003
2 To index the FUNCTION number to 4:	PRESS ▲	004
3 Change to OPTION numbers:	PRESS ★	00.4
4 To alter OPTION number 0 to OPTION number 4:	PRESS ▲▲▲▲	04.4
5 To place in memory:	PRESS P	TEMP
B. USE OF MANUAL RESET		
P and PD mode. When the system has settled, if a discrepancy exists between Set Point and Process Temperature, the 'offset' can be re moved by the use of Manual Reset. For example, if the process temperature is 252°C and the set point is 250°C		
Process temperature is —		252
1 To view the set point temperature:	PRESS ★	250
2 To correct 'offset' of -2°C. Display shows FUNCTION 3, OPTION 0:	PRESS P	003
3 To index to FUNCTION 1:	PRESS ▼▼	001
4 Change to OPTION numbers flashing:	PRESS ★	00.1
5 To key in the 'offset' temperature (2°C):	PRESS ▼▼	-02.1
6 To place in memory: The process temperature reading will settle from 252°C to 250°C	PRESS P	252 250

3.7 NEGATIVE TEMPERATURE RANGING

The following sensor types can be used for negative temperatures. The negative value shown against each type is automatically set by the choice of sensor (Function 16) and requires enabling with Function 17, Option 1.

Type T: −90°C, −130°F
Pt100: −100°C, −148°F
Type N: −50°C, −58°F non-linearized
Type K: −50°C, −58°F non-linearized

3.8 PARAMETER LOCK

The chosen parameters may be permanently locked into memory by removing or altering the position of the jumper behind the lower front bezel (see Figure 3-2). Note that locked positions (2) and (3) are alternatives and that the jumper socket is in the ''inactive'' position in (2).

NOTE

It is important to switch off briefly after changing jumper position.

When the parameter lock has been applied, only the Set-Up adjustments listed below are possible (depress the P key):

1. Adjust manual reset (PD, P and ON/OFF modes only) — see Table 3-8 for key sequences.
2. Adjust the second set point (assuming Function 19, either Options 1, 2 or 3 have been selected).
3. Lock the main set point to prevent adjustment by the operator.

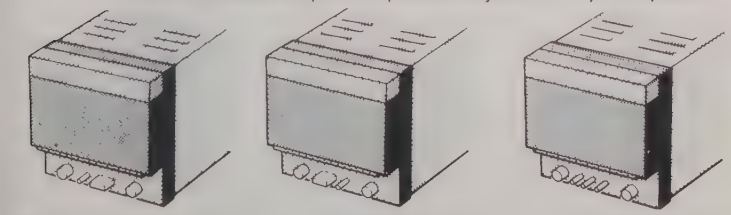


Figure 3-2. Parameter Lock Positions

3.9 FAULT INDICATION

Depending on the selection made at Functions 20 and 21, the SP1 and SP2 outputs are turned ON or OFF if sensor is open. The main temperature display, on a fault indication, is replaced by "EE" flashing, followed by a digit. This indicates that an error has been detected in the system. Action should be taken as follows:

EE1 Sensor burnout. Check sensor and/or connections, then key ★.

EE2 Temporary System Error. Self clearing.

EE8 Loss of calibration. Contact the OMEGA Customer Service Department at (203) 359-1660.

EE9 Non-volatile memory data fault. If you get this error condition, and the device locks up:

Press P key and disconnect the power while it is pressed in.

This will clear the memory. All functions will go to default state and must be reprogrammed.

If you have any other problems, contact the OMEGA Customer Service Department at (203) 359-1660.

3.10 CALIBRATION

The CN9000 is not designed to allow field calibration.

A one point "Display Offset" can be programmed from the front of the unit using Function 9 (Display Bias). This function should not be used in normal operation.

Display Bias can be used to correct for small errors in calibration of a particular thermocouple or the CN9000. It should never be used as a fudge factor to account for temperature gradients in a system.

Note that this is not a true calibration since the entire curve is shifted, and although the unit can be recalibrated at one point, the reading can be off at another temperature since the temperature curve is not exactly linear. Therefore, the Display Bias should be attempted as close to the desired set point temperature as possible.

To set up Display Bias:

1. Power up instrument and allow at least 30 minutes warm-up time.
2. Key into Function 9 as normal.
3. Press ★ and hold.
4. Press ▲▼ .
5. Release ★, and ▲▼ together.
6. Enter Bias Value in (+) or (−) 0.1° increments in Function 9, in normal manner, up to a maximum of 12.7°. (Note that the increments are in °C or °F depending on Function 22 setting.)
7. Press P.
8. Check that the Bais Value has been entered correctly by checking Function 9.

NOTE

In later units, it is no longer required to perform steps 3, 4 and 5; however, if said steps are performed, unit will still function properly.

SECTION 4 TUNING

4.1 THE SIMPLIFIED METHOD

If the pre-set PID Default values prove to be unsuitable for a particular application, the following method can be used to establish new settings which should be acceptable and which can be adjusted to give optimum control. Other methods may also be used — tuning is a trial and error process.

The first step is to control the system with the instrument in ON/OFF mode and use these results to calculate the new parameter values for SP1

Check that all settings are in Default. If required, range adjustments should be made first (refer to paragraph 3.3).

Check that the Parameter Lock is in the Parameter Setting Position (see Figure 3-2) and proceed as follows:

1. Adjust Proportioning Time to ON/OFF. (This switches off all other control terms and sets Hysteresis to 1.25% of full scale.)
2. Key in set point temperature.
3. Switch ON and allow process to stabilize. Monitor process temperature, ideally using a chart recorder, or alternatively by taking readings from the display at regular intervals, as frequently as possible. The results should look similar to Figure 4-1.

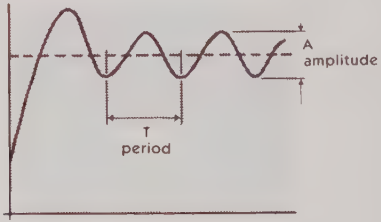


Figure 4-1. Simplified Tuning Method

4. Using the figures obtained for the oscillation period (T) seconds and amplitude (A) degrees (see Figure 4-1), the following parameter values can be calculated:

   a. Proportional Time = $\frac{T}{20}$ If 10 seconds or less use the pulse output module.

   b. Proportional Band % = $\frac{A \times 1.5 \times 100}{\text{full scale}}$ Set to next LARGER % setting.

   c. Derivative (Rate) Time = $\frac{T}{10}$ Set to next SHORTER setting.

   d. Integral (Reset) Time = T Set to next LONGER time setting.

NOTE

Approach control will be activated in DEFAULT setting = 1.5 x prop. band. If the warm up characteristic is unacceptable, refer to paragraph 4.6.

5. Enter these new values and restart the process from cold.

The above settings can be further adjusted to give optimum performance. Paragraphs 4.2 through 4.7 will provide guidance for tuning the individual control terms.

4.1.1 Alternative Tuning Method

If control is not satisfactory, the most likely cause is that the factory (default) settings are unsuitable for your application. To find the best settings for your process proceed as follows step by step.

STEP	ACTION	DISPLAY
1. Lower set point by 10%	Press ★▼	
2. Select setting mode	Press P	003
3. Index to Function 4	Press ▲	004
4. Change to Option 7	Press ★	004
5.	Press ▲ seven times	074
6. Return to operating mode	Press P	

CONTROL MAY NOW BE WORSE—TEMPERATURE WILL SWING ABOVE AND BELOW SET POINT.

7. Observe this swing carefully and note the difference between the highest and the lowest reading (A =) and time in seconds between consecutive highest readings (T =)

8. Locate your sensor in the table below to obtain a sensor factor and use this with value for A to calculate size of "Proportioning Band" **(Function 5).**

Sensor Type	PT100 RTD	T	THERMOCOUPLE TYPES		
			J, K, N, Fe Const.	E	R and S
Sensor Factor	4	5	8	10	32

$$\frac{A \times 3}{\text{Sensor Factor}} \%$$

Use calculated % value for "Programming Band" width to select option number in Function 5 table below. When between fixed values choose next larger option.

Fixed Values	0.5%	1%	2%	2.5%	3%	5%	10%	20%
Option No.	1	2	3	0	4	5	6	7

9. Using value for T (time interval between consecutive highest readings) calculate new value for "Proportioning Time" (Function 4).

$$\frac{T}{20} = \text{seconds}$$

Use calculated value to select option number in **Function 4** table below. When between fixed values choose next shorter option.

	SECONDS							
Fixed Values	1	5	10	20	30	60	0.05	On/Off
Option No.	1	2	3	4	0	5	6	7

NOTE

If options 1, 2 or 3 are selected it is recommended that you use SSD output for SP1. Option 6 is only used for analog output only (4-20 mA DC or 0-10 VDC output)

10. Using same value for T calculate "Derivative Time" (Function 6)

$$\frac{T}{10} = \text{seconds}$$

Use calculated value to select option number in **Function 6** table below. When between fixed values choose next shorter option.

	SECONDS						
Fixed Values	**Out**	**5**	**10**	**25**	**50**	**100**	**200**
Option No.	1	2	3	0	4	5	6

11. Using same value of T select option number in **Function 8** "Integral Time" table below.

	SECONDS							
Fixed Values	**Out**	**25**	**50**	**100**	**200**	**350**	**600**	**1000**
Option No.	1	2	3	4	5	0	6	7

Now enter in new option numbers for functions 4, 5, 6, and 8. P key is used to enter and exit from setting mode. Option numbers are on the left of the decimal point. Function numbers are on the right side of the decimal point. Flashing digits can be raised or lowered using ▲ or ▼ keys. Use ★ key to transfer adjustment from Function to Option column or vice versa.

If this procedure fails to produce good results, repeat observations, calculations, and check controller setting.

4.2 PROPORTIONING TIME

The Proportional Time setting determines the cycle rate of the output device. In the interest of long contact life, this should be the slowest (longest setting) possible if mechanical relay output is being used. Otherwise there is no disadvantage in using faster settings. See Figure 4-2.

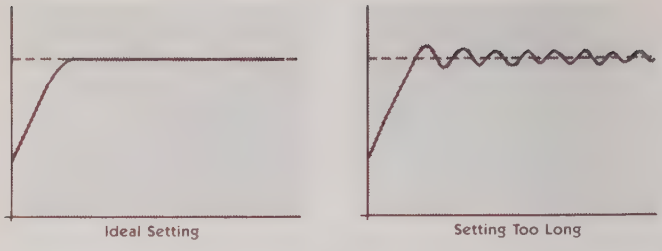


Figure 4-2. Proportioning Time

4.3 PROPORTIONAL BAND

This term is employed to smooth out the oscillating control characteristic typical of ON/OFF control.

A feature of proportional control is that the system may run at a slightly different temperature to the set point (Offset), and have a slower reaction to disturbances. See Figure 4-3.

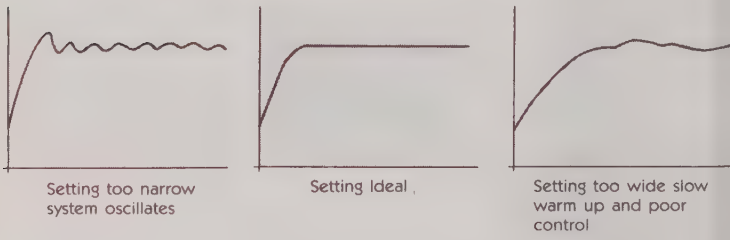


Figure 4-3. Proportional Band

4.4 INTEGRAL (RESET) TIME

The purpose of the integral term is to automatically correct for offset errors caused by the introduction of Proportional control. If incorrectly set, this can cause instability or increase warm up time.

If the Integral Time (constant) is too long, the process will take a long time to return the temperature to the set point. Conversly, if the Integral Time is too short, the process temperature oscillates because the integral action outruns the process. See Figure 4-4.

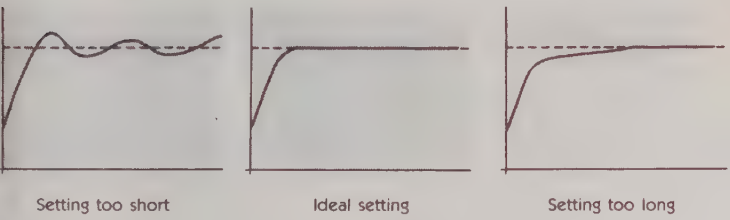


Figure 4-4. Integral (Reset) Time

4.5 DERIVATIVE (RATE) TIME

Derivative enables the controller to shift the proportional band up or down in an amount proportional to the rate of temperature change to help the system compensate for rapidly changing temperature.

The derivative term is added to Proportional Control action to speed up response to disturbances and to suppress overshoot. In applications where these two requirements would need different settings, the use of Derivative Approach Control for adjusting warm-up characters allows the Derivative setting to be biased in favor of disturbance behavior. See Figure 4-5.

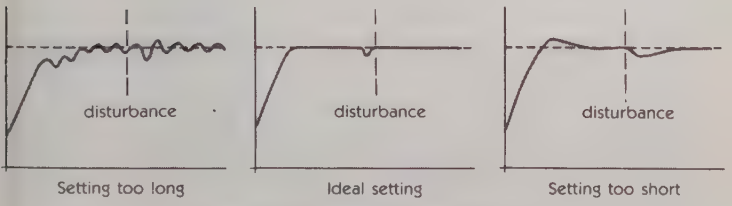


Figure 4-5. Derivative (Rate) Time

4.6 DERIVATIVE APPROACH CONTROL

This feature allows the warm-up characteristics to be tuned separately from normal running conditions and is particularly useful for applications where the sensor is some distance from the heater. The setting determines where the derivative action starts with respect to set point. The smaller the setting, the closer to set point. See Figure 4-6.

Figure 4-6. Derivative Approach Control

Where a given application cannot be tuned to give acceptable results over the required range of process temperatures and conditions, it is possible that better results may be obtained with Proportional, Derivative and Approach Control terms only.

4.7 HEATING AND COOLING GENERAL CONSIDERATIONS

Ideal settings for these systems are very dependent on the application, and are often best determined by experiment.

The following general points may prove useful for initial consideration:

1. A common characteristic is that there is a considerable difference between the system response to the input of heating and of cooling energy.

2. In general, both channels can be set independently using the tuning guidelines for settings for Proportioning Time and Proportioning Band, and where it is known that one channel has a dominating and rapid effect on system temperature, the employment of narrow hysteresis ON/OFF settings for this may give excellent results.

3. Where both set points are required to be set close together (small deadband), wide proportioning or hysteresis band settings will overlap allowing simultaneous operation of outputs, which may give the best overall control.

SECTION 5 SPECIFICATIONS

POWER: Dual 115/230 V ±15% 50-60 Hz 5VA, factory set, jumper changeable

OUTPUT MODULES

DUAL OUTPUT (STANDARD): SP1 Relay — SPDT relay, rated 5 A at 250 V continuous use, 10 A at 250 V maximum; SP2 Relay — SPDT relay, rated 3 A at 250 V continuous use, 5 A at 250 V maximum

NOTE

Although SP1 relay is capable of handling a current of 10 A and SP2 a current of 5 A, the life of the relays will be considerably reduced if the controller is used continuously (24 hours/day) at or near 10 A (SP1) or 5 A (SP2)

Using the controller in an elevated ambient temperature, or with a slightly inductive load, also derates the relays. Therefore, the rating of SP1 is 5 A and SP2 is 3 A.

OPTIONAL OUTPUTS

FOR SP1 & SP2:

PULSE OUTPUT (SSD): Non-isolated 5 Vdc for driving external relay

FOR SP1 ONLY (USING PLUG-IN OUTPUT POWER SOCKET, SUPPLIED)

SSR: 1A/264V 100 VA max, SPST

4-20 mA: Isolated, 500 Ωmax.

0-10 V: Isolated, 20 mA max.

SPECIFICATIONS (Cont'd)

ACCURACY & RANGES

CALIBRATION ACCURACY:	±0.25% of range ±1°C (±0.5°C in Hi-res)
CONTROL STABILITY:	Typically ±0.15% of full scale, dependent on application
MAIN TEMPERATURE SET POINT (SP1):	See Table 5-1
FULL SCALE (FS):	See Table 5-1
SAMPLING TIME:	3 samples per second. Re-zero of CJC and auto calibrate every 5 seconds
TEMPERATURE COEFFICIENT:	<150ppm/°C of max. linearized range typical
REFERENCE CONDITIONS:	22°C ±2°C, 115/230 V ±15%, after 30 minutes settling time

SENSORS

INPUT TYPES:	Thermocouple types J, K, E, R, S, N, J DIN, 2-wire Pt RTD, user selectable; 3-wire Pt RTD
EXTERNAL RESISTANCE (TC):	100 ohms max.
COLD JUNCTION COMPENSATION:	0.05°/°ambient typical
BURNOUT PROTECTION:	Fault display, upscale (downscale key selectable)
COMMON MODE NOISE REJECTION:	140 dB, 240 V, 50-60 Hz
NORMAL MODE NOISE REJECTION:	60 dB, 50 Hz

CONTROL MODES

DEFAULT (PRE-SET) MODE:	SP1: PDPI (Proportional + Derivative + Integral (with Approach Control); Cycle Rate (prop time) 30 sec; Gain (prop band) 2.5% of FS; Rate (derivative time) 25 sec; Reset (integral time) 350 sec.; SP2: Off (inactive)

TABLE 5-1
DISPLAY- LINEARITY AND DEFAULT SETTINGS

SENSOR TYPE	LINEARIZED RANGE	TOLERANCE ±	DEFAULT SETPOINT ADJ
J	0 to 800°C	1°C	400°C
K	0 to 1200°C	1°C	400°C
N	0 to 1200°C	1°C	400°C
R	0 to 300°C 300 to 1600°C	4°C 2°C	1600°C
S	0 to 400°C 400 to 600°C 600 to 1600°C	4°C 2°C 1°C	1600°C
T	−90 to 250°C	1°C	250°C
E	0 to 600°C	1°C	500°C
J DIN	0 to 800°C	1°C	400°C
Pt100 RTD	−90 to 250°C 250 to 400°C	0.25°C 0.5°C	200°C

KEY SELECTABLE MODES (also see Table 5-2)

SP1: PID (3 TERM), PD, P or on/off, PDP (with Approach Control in PD mode)

SP2: Alarm high, alarm low or ''out of limits'', adjustable ±0° - 99°C/F about SP1 setting control modes — on/off, or Proportional

DISPLAY: 3½ digit green LED, 10 mm (0.4") high; 1 or 0.1° resolution; error indication, deviation from set point indicators (3 LEDs)

TABLE 5-2
KEY SELECTABLE PARAMETERS

Key selectable parameters — SP1			Default
Tp1	Cycle rate/prop time 50 ms, 1, 5, 10, 20, 30, 60 secs • Fast cycle < 10 sec, SSR or SSd/logic recommended • Cycle rate > 1 sec, min on/off times 0.5% x Tp1 • Linear dc, internal/external, key 50ms cycle rate		30 sec
Xp1	Gain/prop band	0.5, 1, 2, 2.5, 3, 5, 10, 20% x Span	2.5%
Td1	Rate/derivative time	off 5, 10, 25, 50, 100, 200 sec	25 sec
Ac	Approach control	0.5, 1, 1.5, 2, 2.5, 3, 4, 5 x XP1 Derivative activated about SP1	1.5
Tv	Integral/auto reset	off 25, 50, 100, 200, 350, 600,1000 sec	350 sec
MR	Manual reset	PD, P & on/off modes, ±99°C/F about SP1	0°
Xsd1	Hysteresis	0.25, 0.5, 1, 1.25, 1.5, 2.5, 5, 10%xSpan On/off mode only	None

Key selectable parameters — SP2	Default
Tp2/Xp2/Xsd2 Cycle rate/gain and hysteresis as SP1	None

GENERAL

AMBIENT TEMPERATURE: 5° - 49°C (40° - 120°F)

NOISE IMMUNITY: Tested for power interference on Shaffner 200/222 Interference Simulator, no effect on stored data. Normal control restored within a short time after major power disturbance and "brown outs".

DATA RETENTION: 10 years with instrument unpowered

SAFETY STANDARDS: Designed in accordance with: UL 873 — Industrial Temperature Controllers, CSA C22.2/24-1981, VDE 0411 Class 1; Moldings in flame retardant polycarbonate

DEGREE OF PROTECTION:	Designed in accordance with: IEC 529:1976 BS 5490:1977; Bezel assembly IP-54 "Protected against splashing water and dust"; Case inside panel IP-30 "Protected against > 2.5 mm dia. objects"
DIMENSIONS:	48 x 48 x 13 mm (1.89" x 1.89" x 0.5") bezel; 115 mm (4.4") depth behind panel
PANEL CUTOUT:	45 mm square (1.772" square) per DIN
WEIGHT:	380 g

ADDENDUM A INTERNAL JUMPER CHANGES FOR 115/230 VAC AND 2-WIRE/3-WIRE RTD CONVERSIONS

Voltage and RTD 2-wire/3-wire conversions require wire solder jumper changes on the analog PCB. THESE MODIFICATIONS SHOULD BE MADE ONLY BY A QUALIFIED TECHNICIAN.

NOTE

Use 22 SWG 19 AWG or 0.71 mm 2 tinned copper wire for jumpers.

To remove analog PCB refer to Figure A-1 and proceed as follows:

1. Separate the output module assembly from the main module by gently levering the retaining clips from both slots in the cover with a screwdriver.
2. Remove the output module and then pull the analog PCB from the main module cover.

Figure A-1. Removing Analog PCB

A.1 115/230 VAC VOLTAGE CONVERSION

To convert from 115 Vac to 230 Vac, refer to Figure A-2 and proceed as follows:

1. Remove jumpers 3 and 5.
2. Fit solder jumper 4.

To convert from 230 Vac to 115 Vac, refer to Figure A-2 and proceed as follows:

1. Remove jumper 4.
2. Fit solder jumpers 3 and 5.

A.2 2-WIRE/3-WIRE RTD CONVERSION

NOTE

Use of a 3-wire RTD reduces display error when lead length is over 10M/30'

To convert from a 2-wire RTD to a 3-wire RTD, refer to Figure A-2 and proceed as follows:

1. Cut track where marked X on PCB.
2. Fit solder jumpers 1 and 2.

NOTE

Conversion to a 3-wire RTD inhibits subsequent selection and use of thermocouples.

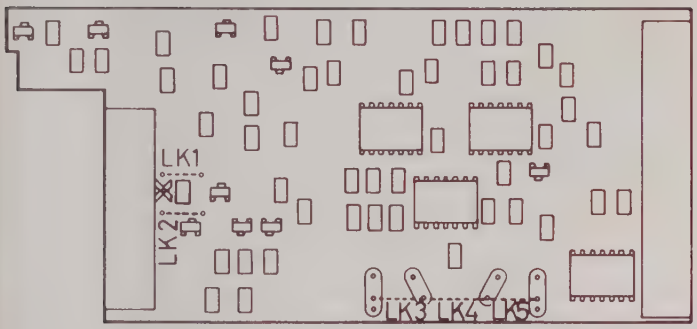


Figure A-2. Voltage and 2-Wire/3-Wire RTD Conversions

A.3 INSTALLING THE TRIAC OUTPUT, 4-20mA AND 0-10 Vdc OUTPUT OPTIONS

The modules with 1A Triac, 4-20 mA dc or 0-10Vdc outputs require a unit which has a SSD logic 5V pulse on the first output, such as CN9121 or CN9221.

The BD9031, BD9041, or BD9051 power socket can then be plugged on the back of the unit in place of the standard socket used for wiring.

Hardware required to make units is as follows:

CN9121 + BD9031 → CN9131
CN9121 + BD9041 → CN9141
CN9121 + BD9051 → CN9151
CN9221 + BD9031 → CN9231
CN9221 + BD9041 → CN9241
CN9221 + BD9051 → CN9251

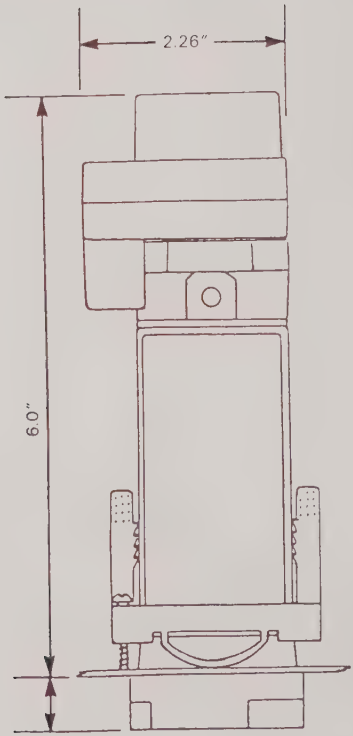


Figure A-3. Dimensions with the Power Socket

NOTES

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